EFFICIENCY ENHANCEMENT OF CLUSTER STABILITY AND ENERGY CONSUMPTION IN THE CLUSTERING ALGORITHMS

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ABSTRACT

Ad Hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any centralized administration, in which individual nodes cooperate by forwarding packets to each other to allow nodes to communicate beyond direct wireless transmission range. The main focal point of the work is to enhance Weighted Clustering Algorithm (WCA) and other similar algorithms like Weighted based hierarchical clustering algorithm, An On-Demand Weighted Clustering Algorithm. The node degree is considered as an important weight metric in cluster head selection process. Regrettably this metric is not steady especially when it is considered separately at the node environment such as the neighbors' location within the transmission range zone of this node. To overcome this inefficiency, two new models node degree aggregation model and range zone aggregation model are going to propose. Thereafter these two models are combined to gain their efficiencies. The new combined model motivates to generate and reformulate many node degree based formula given in literature and dealing with Quality of Clustering (QoS) as stability and load balancing clustering parameters. Then the models will show that it outperforms WCA in the in terms of cluster formation and stability.

Keywords: Mobile Ad Hoc Networks, Clustering, Gateway, Cluster Head Election, Node Degree

I INTRODUCTION

Ad hoc networks are wireless, infrastructure less, multi-hop, dynamic networks established by a collection of mobile nodes. The network is ad hoc because it does not rely on a pre existing infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. There are no base stations or mobile switching centers in an ad hoc network. Since, there is no fixed infrastructure; a wireless ad hoc network can be deployed quickly. Thus, such networks can be used in situations where either there is no wireless communication infrastructure or situation where such infrastructure cannot be used because of security, cost or safety reasons.

Ad-hoc networks are mainly used for military applications. Since then, they have become increasingly more popular within the computing industry. Applications include emergency search and rescue operations, deployment of sensors, conferences, exhibitions, virtual classrooms and operations in environments

In Ad hoc networks nodes within the transmission range can communicate directly with each other. Nodes outside the transmission range must communicate indirectly using a multi hop routing protocol. Instead of that many clustering schemes have been proposed to organize the manet into a hierarchy with a view to improve the efficiency of routing .clustering is defined as a way to reconfigure all nodes into small virtual groups according to their regional vicinity. Cluster structure consist of three kinds of nodes namely cluster head, cluster members (ordinary node) and gateway nodes

The major issues in cluster based MANETs are topology management, mobility management, overhead of cluster head and frequent leader re-election. There are no stationary nodes or base stations, each node in the network act as the router that forwards the packet to other nodes. Due to the node heterogeneity, nodes will have highly variable amount of resources and this produces the hierarchy in their roles inside the networks. Cluster heads are analogous to the base station concept in current cellular systems. Electing the leader for a cluster is very important but sophisticated job. The factors like location of the node, mobility, energy and throughput are considered in electing the cluster head. Communication done with the node in the other cluster can be done through gateways. Gateways are nodes that can hear two or more cluster heads.

Gateway nodes are located at edge or boundary of the cluster which listen to transmissions from another cluster's node. Ordinary nodes send the packets to their cluster head that either distributes the packets inside the cluster, or (if the destination is outside the cluster) forwards them to a gateway node to be delivered to the other clusters. By replacing the nodes with clusters, existing routing protocols can be directly applied to the network. Only gateways and cluster heads Participate in the propagation of routing control/update messages. In dense networks this significantly reduces the Routing overhead, thus solving scalability problems for routing algorithms in large ad hoc networks.

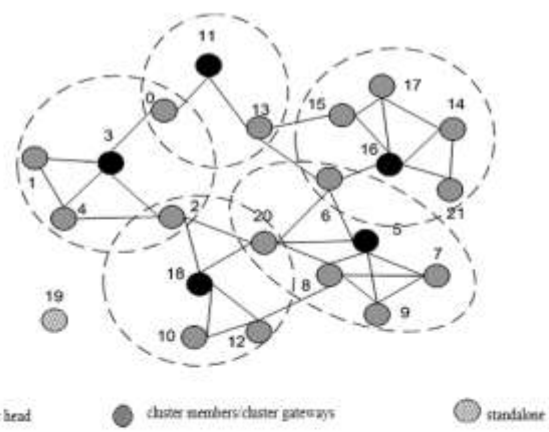


Figure 1.2 Illustration of cluster structure after cluster formation

1.1 Clustering In Manet

A successful approach for dealing with the maintenance of mobile ad hoc networks is by partitioning the network into clusters. In this way the network becomes more manageable. It must be clear though that a clustering technique is not a routing protocol. Clustering is a method which aggregates nodes into groups. These groups are contained by the network and they are known as clusters. A cluster is basically a subset of nodes of the network that satisfies a certain property. Clusters are analogous to cells in a cellular network. However, the cluster organization of an ad hoc network cannot be achieved offline as in fixed networks.

Clustering presents several advantages for the medium access layer and the network layer in MANET. The implementation of clustering schemes allows a better performance of the protocols for the Medium Access Control (MAC) layer by improving spatial reuse, throughput, scalability and power consumption. On the other hand, layer by reducing the size of the routing tables and by decreasing transmission overhead due to the update of routing tables after topological changes occur.

Clustering helps aggregate topology information since the number of nodes of a cluster is smaller than the number of nodes of the entire network. Therefore, each node only needs to store a fraction of the total network routing information. The purpose of a clustering algorithm is to produce and maintain a connected cluster. In most clustering techniques nodes are selected to play different roles according to a certain criteria. In general, three types of nodes are defined clustering helps improve routing at the network

1.1.1 Ordinary Nodes

Ordinary nodes are members of a cluster which do not have neighbors belonging to a different cluster.

1.1.2 Gateway Nodes

Gateway nodes are nodes in a non-cluster head state located at the periphery of a cluster. These types of nodes are called gateways because they are able to listen to transmissions from another node which is in a different cluster. To accomplish this, a gateway node must have at least one neighbor that is a member of another cluster.

1.1.3 Cluster-heads

Most clustering approaches for mobile ad hoc networks select a subset of nodes in order to form a network backbone that supports control functions. A set of the selected nodes are called cluster heads and each node in the network is associated with one. Cluster heads are connected with one another directly or through gateway nodes. The union of gateway nodes and cluster heads form a connected backbone.

1.1.4 Why do ad hoc networks require clustering?

It has been shown that cluster architecture guarantees basic performance achievement in a MANET with a large number of mobile terminals. A cluster structure, as an effective topology control means, provides at least three benefits.

First, a cluster structure facilitates the spatial reuse of resources to increase the system capacity. With the non-overlapping multi cluster structure, two clusters may deploy the same frequency or code set if they are not neighboring clusters. Also, a cluster can better coordinate its transmission events with the help of a special mobile node, such as a cluster head, residing in it. This can save much resources used for retransmission resulting from reduced transmission collision.

The second benefit is in routing, because the set of cluster heads and cluster gateways can normally form a virtual backbone for inter-cluster routing, and thus the generation and spreading of routing information can be restricted in this set of nodes. Last, a cluster structure makes an ad hoc network appear smaller and more stable in the view of each mobile terminal. When a mobile node changes its attaching cluster, only mobile nodes residing in the corresponding clusters need to update the information. Thus, local changes need not be seen and updated by the entire network, and information processed and stored by each mobile node is greatly reduced.

II RELATED WORK

Several heuristics have been proposed to choose cluster heads in an adhoc network.

2.1 Lowest-ID Clustering Algorithm (LIC)

The node with the minimum ID is chosen to be a cluster head. Major drawbacks of this algorithm are its bias towards nodes with smaller ids which may lead to the battery drainage of certain nodes, and it does not attempt to balance the load uniformly across all the nodes.

2.2 Highest Connectivity Clustering Algorithm (HCC)

This algorithm is also known as connectivity-based clustering algorithm. Each and every node will broadcast its ID to the neighbor nodes within its transmission range. The degree for each node is calculated and the node that contains the maximum number of neighbors is selected as the cluster head. Disadvantages are there will be lower throughputs when the degree of the node increases

2.3 Weighted Clustering Algorithm (WCA)

The weighted clustering algorithm (WCA) is based on the use of a combined weight metric. i.e., the number of neighbors, distance with all neighbors, mobility and cumulative time for which the node acts as the cluster head. The weight values are broadcast by each node and so each node knows the weight values of all other nodes and other cluster heads in the system.

2.4 An On-Demand Weighted Clustering Algorithm (WCA) for Ad hoc Network

In this work, a weighted clustering algorithm (WCA) is presented which takes into consideration the number of nodes a cluster head can handle ideally (without any severe degradation of the system performance), transmission power, mobility and battery power of the nodes. Most of the existing clustering algorithms are invoked periodically but this algorithm is not periodic. Its invocation is adaptive based on the mobility of the nodes. More precisely, the election procedure is delayed as long as possible to reduce the computation cost. Frequent updates result in high information exchange among the nodes resulting in high communication overhead. The algorithm is executed only when there is a need, i.e., when a node is no longer able to attach itself to any of the existing cluster heads. This algorithm performs significantly better than both of the Highest- Degree and the Lowest-ID heuristics.

2.5 Distributed Clustering for Ad Hoc Networks

Distributed Clustering Algorithm (DCA) is presented that generalizes the previous approaches by allowing the choice of the cluster heads based on a generic weight associated to each node: The bigger the weight of a node, the better that node for the role of cluster head.

III EXISTING SYSTEM

In the existing system, a weight based distributed clustering algorithm (WCA) is presented which can dynamically adapt itself with the ever changing topology of ad hoc networks is proposed. In this approach, the number of nodes is restricted to be catered by a CH, so that it does not degrade the MAC functioning. It also has the flexibility of assigning different weights and takes into account a combined effect of the ideal degree, transmission power, and mobility and battery power of the nodes. The cluster head selection problem is considered in wireless ad-hoc networks where it is necessary to provide robustness in the face of topological changes caused by node motion, node failure and node insertion or removal. The main contribution of this work is a new strategy for clustering a wireless AD HOC network and improvements in WCA and other similar algorithms. Some analytical models are derived and thereafter some clustering schemes. This contribution also extends previous works in providing some properties and analyses of Quality of Clustering (*QoC*) in ADHOC.

The main drawbacks of the system are

- less energy efficient
- less accuracy of cluster head selection
- less stability

IV PROPOSED SYSTEM

In the proposed system, an innovative technique is introduced which is called Enhanced Quality of Clustering (EQoC) for reducing the energy consumption. Cluster Head (CH) election is the process to select a node within the cluster as a leader node. Cluster Head maintains the information related to its cluster. This information includes a list of nodes in the cluster and the path to every node.

The contributions of this work are:

(1) In this method, instead of reelecting cluster head the current cluster head assigns the cluster head before its going to dead so that the re-clustering is reduced ,energy is save by reducing re-cluster. If the new cluster head is elected the current cluster head provides their backup details to that new cluster head. The backup

details include considering the number of clusters and number of cluster heads within the transmission range of the non cluster head sensor nodes in their clusters.

(2) Suppose, if the two nodes having same value the centre of the node is elected as cluster head. Suppose, if it is in the cluster edge check with the nearest cluster. Suppose, if it is in the cluster edge check with the nearest cluster.

By using this enhanced quality-of-clustering method, the high amount of energy is saved.

4.1 NQCA: Node Quality Based Cluster Algorithm

A combined weight clustering algorithm is used to establish a stable clustering architecture in the proposed system. The proposed algorithm and it has a hierarchical structure that can maintain the topology of MANET as stable as possible. Thereby optimizing network performance and making efficient resource allocation for nodes. This makes it possible to maintain efficient and stable topology in MANET environment. In this algorithm, the node with the highest fitness is elected as the CH. In the proposed algorithm, due to the weight metric, cluster creation is done very quickly which causes network services to be more accessible. The CH is selected efficiently based on these factors like high transmission power, transmission range, distance mobility, battery power and energy. Since the CH will not be changed dynamically, the average number of cluster formations will be reduced.

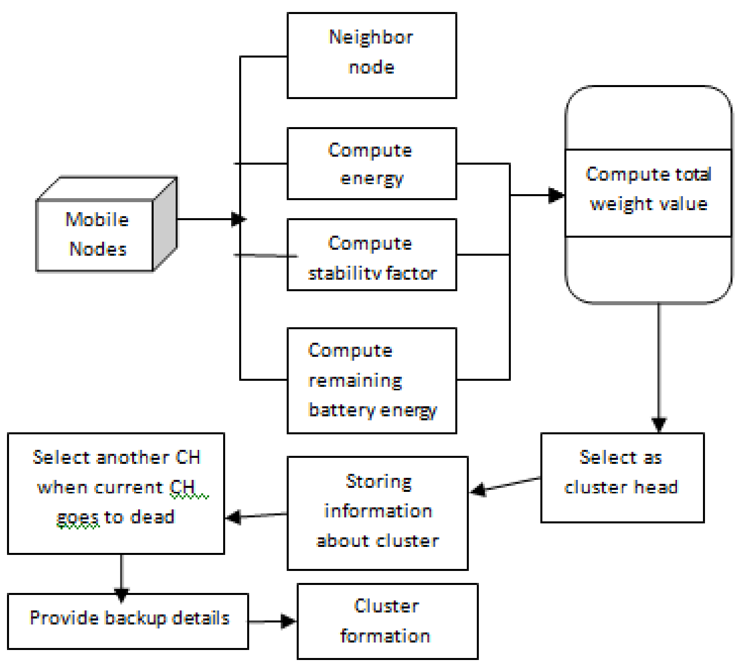


Fig 4.1 Block diagram for proposed system

The NQCA algorithm that effectively combines parameters degree, transmission power, and mobility and battery power of the nodes with certain weighting factors according to the system needs. The flexibility of changing the weight factors helps apply this algorithm to various networks. The output of CH election procedure will be a set of nodes called the dominant set. The CH election procedure is invoked at the time of system activation and also when the current dominant set is unable to cover all the nodes. Every invocation of the election algorithm does not necessarily mean that all the CHs in the previous dominant set are replaced with the new ones. If a node detaches itself from its current CH and attaches to another CH, then the involved CHs update their member list instead of invoking the election algorithm.

NQCA structure

This algorithm is composed of two parts

i) CH selection

ii) Cluster member grouping

4.1.1 CH selection

4.1.1.1 Node priority aggregation model:

CH selection process priorities to the nodes based on their degree in this order: priority of strong node>priority of weak node> priority of border node. For this purpose, introduce the node type indicator (ntype), which is calculated as follows:

$$ntype(v_i) = \begin{cases} 1, \ \deg(v_i) \geq 3 & (SN: strong\ node) \\ 2, \ \deg(v_i) = 2 & (WN: weak\ node) \\ 3, \ \deg(v_i) = 1 & (BN: border\ node) \end{cases}$$

4.1.1.2 Range zone aggregation model

The first two zones contain trusted neighbors whose neighborhood is guaranteed for a well-defined period. However, the other neighbor nodes, which are situated in the *risked zone*, are considered as topologically unfavorable (not trusted) nodes because they can be assumed to leave the partition earlier than trusted nodes. To give higher priority to trusted nodes and less priority to not trusted nodes during the CH selection processes

4.1.2 Cluster member grouping

This stage constitutes the final step of NQCA algorithm and represents the construction of the cluster members' set. Each CH defines its neighbors at two hops maximum, which form the members of the cluster. In the following step, each CH stores all information about its members, and all nodes record the CH identifier.

- **Node quality**

  "The node quality" is calculated as follows:

  $$ndq(v_i) = comind(v_i) \times deg(v_i)$$

- **Clustering stability** enhancement

  Despite the node mobility in MANETs, the cluster structure should be kept as stable as possible Otherwise, frequent cluster change or re-clustering adversely affects the performance of radio resource allocation and scheduling protocols By stability, it mean that the cluster structure remains unchanged for a given reasonable time period. Stability factor for each node as follows:

$$STF(v_i) = ZD(v_i)/ndq(v_i)$$

- **Energy consumption**

In Adhoc network known that more power is required to communicate to a larger distance. Therefore, they evaluate the energy consumption. For this purpose every node, compute the sum of the distances with its neighbors

$$D(v_i) = \sum_{j=1}^{n} dis(v_i, v_j)$$

- **Remaining battery energy**

The weakness in WCA is computing the cumulative time during which a node acts as a CH. This cannot guarantee a good assessment of energy consumption because data communication consumes a large amount of energy and varies greatly from node to node. Each mobile node can easily estimate its remaining battery energy (RBE). A node with longer remaining battery lifetime is a better choice for a CH.

- **Combined Weight**

$$W(v_i) = w_1 ZD(v_i) + w_2 RBE(v_i) + w_3 STF(v_i) + w_4 \beta(v_i)$$

V SIMULATION RESULTS

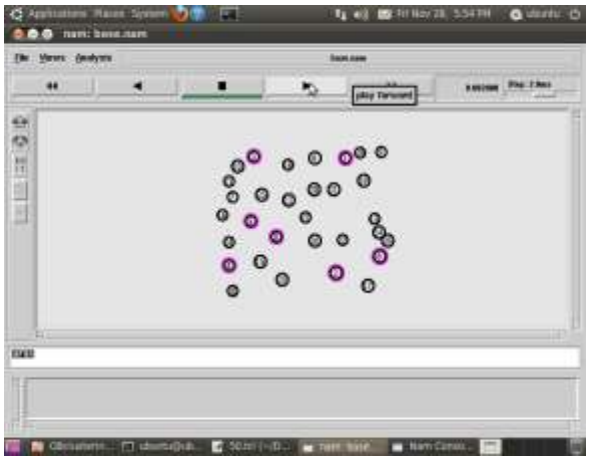
In the table the parameters of the simulation are presented. Each node is randomly distributed in 1000x1000m physical area. Number of nodes was change from 10 to 80 in steps of 10. Weight parameters are equal: W1 = 0.25 for degree of the node, W2 = 0.35 for received power level, W3 = 0.20 for the stationary factor and W4 = 0.20 for the battery level. The simulation time was the same for all scenarios and equal 170 s.

Parameter	Value
network area	1000 x 1000 m
number of nodes	20 – 80
transmission range	160 – 240 m
simulation time	170 s
speed	0 – 10 m/s
weight 1	0.25
weight 2	0.35

Performance Metrics

To performance evaluation of the algorithm, four metrics will be observed:

- The average number of created clusters versus transmission range,
- The average number of created clusters versus number of nodes,



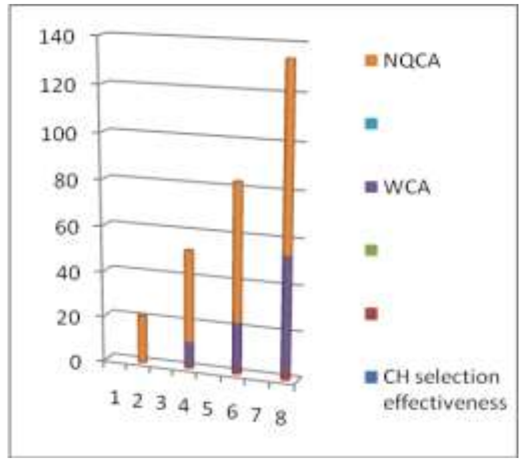


Fig 5.1 cluster head formation

Fig 5.2 CH selection effectiveness

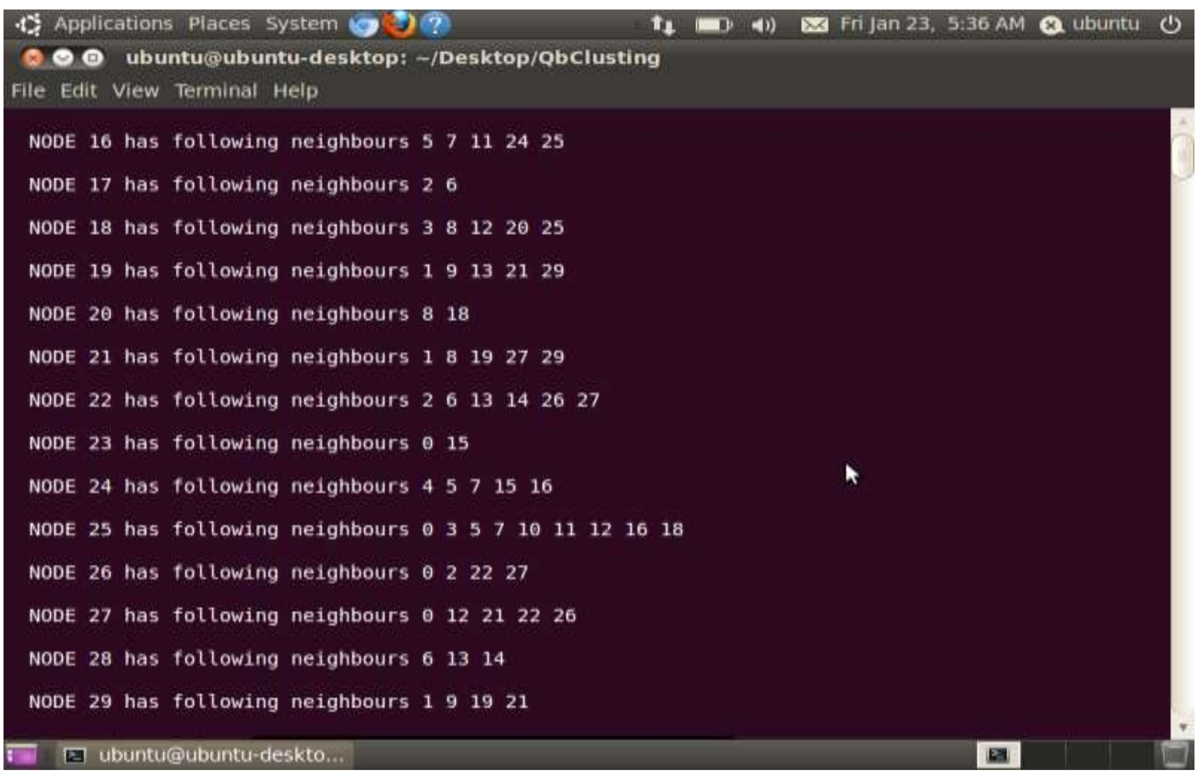


Fig 5.3 Neighbor node estimation

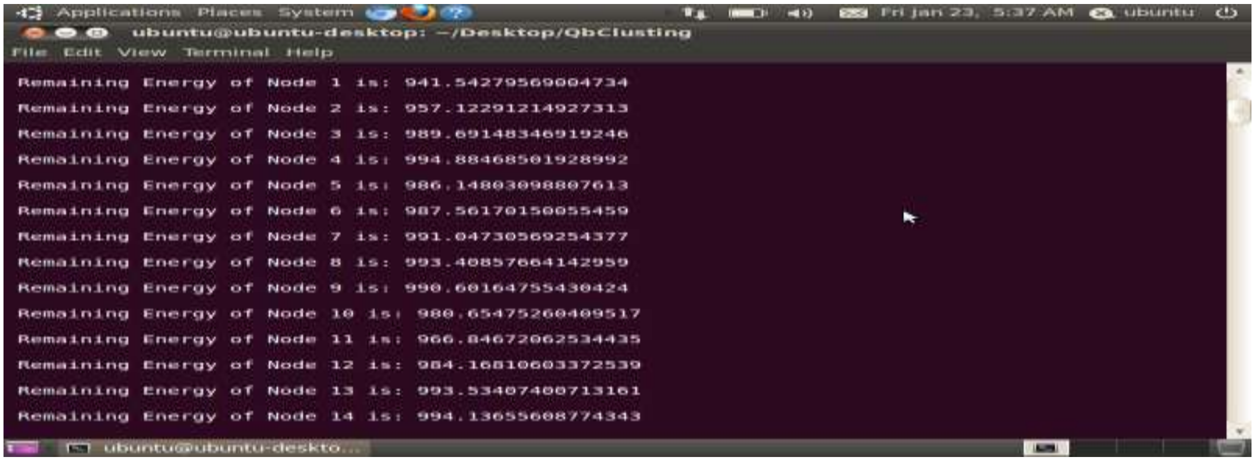


Fig 5.4 Calculation pf Remaining energy of the nodes

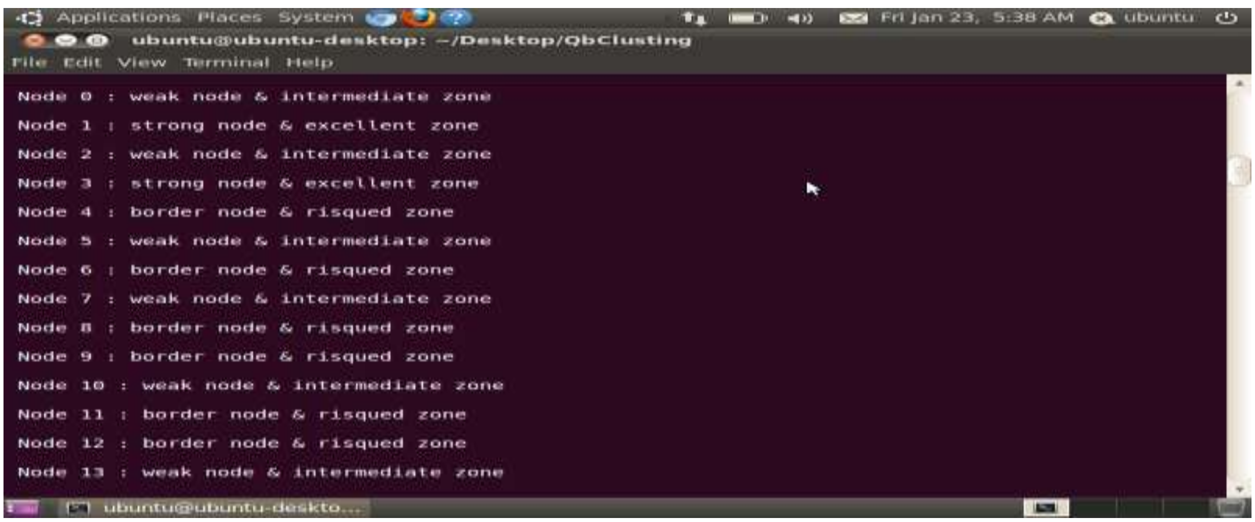


Fig 5.5 Identification of Node Quality

VI CONCLUSION

This work proposes to use node priority and zone range in the clustering algorithm. Thereby cluster stability and energy consumption will be improved. These proposed schemes overcome some inefficiencies detected in WCA and other similar clustering algorithms. It was shown that the performance of our proposed clustering algorithm is similar to the best well-known algorithms, such as the WCA.

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